Marine VHF Antennas (aerials) and their installation

By John Schofield

VHF radio range is line of sight, so height is a very important factor in achieving maximum range. On a yacht the most suitable antenna location is, therefore, at the top of the mast. Two boats, each with a masthead antenna 60' above sea level can theoretically communicate at about 22 miles. A transmitter at a coast station, perhaps 1000 feet above sea level, could communicate with these same boats at closer to 50 miles. On a power boat you have to do what you can to place the antenna as high as possible above sea level.

For those who wish to do the maths themselves the formula is: Distance is equal to $1.4(\sqrt{H1} + \sqrt{H2})$, where H is the height of the antennas in feet. The constant, 1.4, takes into account the fact that the radio waves bend slightly so they can 'look' over the horizon some distance. In certain atmospheric conditions much greater ranges have been noted but this can't be relied upon.

If the VHF antenna is to serve an AIS engine you have slightly different priorities; you could consider taking the opportunity to provide redundancy for your radio antenna. On a yacht it makes sense to put the AIS antenna on the rail so that if you are dismasted this antenna can take over the duties of the masthead antenna. Terminate the cable in a PL259 and use an SO239/BNC adapter to allow you to connect to the AIS engine's BNC coupling. Then, if you need to switch this antenna to radio use, you just remove the adapter and connect into the back of the radio. Make sure you have enough cable to reach both pieces of equipment. Ships transmit their AIS information from antennas high above sea level, so even with a rail mounted antenna you are likely to enjoy a range of around 12 miles or so – half an hour before a fast moving ship can reach your location.

It is a simple fact that the potential performance of a marine VHF radio is limited by the quality of the antenna and its installation. A badly designed antenna fitted with undersized cable and imperfect connections will make the performance of even the most exquisite and expensive radio unacceptable.

A penny in the antenna is worth a pound in the radio.

It is important to select the right antenna and install it in such a way that it maximises the performance of the radio or AIS engine to which it is attached.

<u>Selecting an antenna</u>

Antenna performance, or *gain*, is expressed in decibels – dBi. A 9dBi antenna increases the signal strength eightfold, a 6dBi antenna fourfold and a 3dBi antenna, the best selection for masthead applications, doubles signal strength.

But why choose a 3dBi antenna for the masthead when you could get all that extra power from a 9dBi antenna?

Well, the increased signal strength of a high gain antenna is achieved by concentrating the signal radiating from it into a narrow disc – the transmitted power doesn't increase, just becomes more focused. The signal radiates at right angles to the antenna with very little radiation upwards or downwards. When the boat heels and the antenna rocks backwards and forwards the concentrated disc-like radiation pattern points the signal at the sky, or at the sea, instead of at the horizon. A 3dBi gain antenna has a radiation pattern that looks more like a fat doughnut than a disc, with a significant portion of the signal radiating upwards and downwards. No matter how much the boat heels, such an

antenna will still have some portion of its signal looking at the horizon and, because VHF transmissions are line-of-sight, this is vital to performance. Hence the universally accepted use of a 3dBi gain antenna for boating applications, particularly for masthead mounting.

Another measure of antenna performance is the SWR – Standing Wave Ratio. (You may see this referred to as VSWR, Voltage Standing Wave Ratio, but it is the same thing). This is, in very simple terms, a measure of the amount of the transmission power that is lost in the antenna system. If the antenna system were perfect and the entire signal power leaving the radio was transmitted by the antenna (and its cables and connections) the SWR would be 1:1. Sadly this is not achievable, but getting as close as possible is a worthy aim. A SWR of 2.0:1 over the whole system represents a ½ dB loss in signal strength and is barely acceptable. To achieve or, preferably, better this performance the antenna itself should have the best possible SWR. A top quality antenna such as the Metz Manta-6 has a SWR of less than 1.2:1. Others will have an SWR of 1.5:1 or higher.

Other criteria for selecting a marine antenna, particularly one for masthead mounting, would be:

- Resistance to UV degradation. Clearly all stainless steel construction wins hands down.
- Resistance to bird strikes. Again, a stainless steel whip is less vulnerable than a rigid plastic one.
- Ability to be removed when the mast is taken down. This is when the antenna is particularly vulnerable and those with factory crimped connections cannot be removed without removing all the cable with them. The connection at the antenna should be an SO239 socket which takes the standard PL259 connector.
- Low weight.
- Sturdy mounting bracket.

The Metz antenna satisfies all these criteria. Its excellent durability as a result of stainless steel construction combined with superb performance makes it the choice of the US Coastguard and UK Search & Rescue services.

Metz VHF antenna

Once the antenna has been selected we can turn to the other components of the antenna system; the cable and connectors.

<u>Cable:</u>

Marine VHF applications require 50 ohm coax. TV cable is 75 ohm and is not suitable.

Suitable cables include RG-58 (smallest), RG-8X, RG-8U and RG213. RG-213 is the same size as RG-8U but with completely waterproof and ultra-violet resistant insulation. RG-213 is more difficult to work with when it comes to making connections and is very expensive, so probably best left to superyachts. RG58 is only suitable for interconnections between equipment and for very short runs.

RG-8X is recommended for runs up to about 15 or 20 meters and RG-8U for longer runs. (This is also the recommendation of the IOC and ISAAF as the best means of achieving their Cat 1 offshore race requirement for an antenna feeder cable with less than 40% loss)

Marine coax must be tinned copper, both the braid and the stranded centre core. Braid coverage is important – over 95% is excellent, below 90% not acceptable. A good UV resistant cover is essential for longevity.

Ancor Marine Products and Berkshire Cable both produce a top quality RG8X cable suitable for marine applications.

Connections:
One of the biggest causes of failure in an antenna system is faulty connections. These allow water into the coaxial cable causing corrosion of the braid and centre conductor. So, high quality connectors are required.

The cable terminal at the radio is the PL-259 plug. This plug fits the SO239 socket fitted to all VHF radios. A PL259 connector also mates with the SO-239 socket as fitted to the Metz Manta and other top quality antennas.

SO 239 socket at the base of a Metz antenna

PL259 connector

Two lengths of cable can be connected together using two PL-259's and a barrel connector.

Connections should be soldered. Some antenna manufacturers use factory fitted pressure crimped connections but these are subject to corrosion and need special tools to create the connection. Remember, you should be able to remove the antenna when the mast is taken down for winter storage.

Cable run:
An ideal installation would have the cable make an uninterrupted run from the antenna connector to the radio socket but this is not always practical. A good compromise is to make the connection inside the boat, out of the harsh marine environment. A cable gland through which the entire PL259 plug will pass is available so that an interior connection can be made without the need to remove the plug when removing the mast. The masthead connection and any other exterior connections should be protected with self-amalgamating tape.

A cable deck gland that allows the cable with PL259 connector attached to pass through it.

The coaxial cable can be run inside or outside the mast. If the run is on the outside it is particularly important to have a UV resistant cover; a white exterior jacket looks less industrial on most masts than the more common black or brown cable.

If the cable is inside the mast it should be restrained to prevent tangling with halyards or other cables, and to avoid the maddening rapping of the cable against the mast. Modern mast sections have in-built channels through which the cable can be run. Older masts should, if at all possible, have a conduit fixed inside. As a last resort the cable can be fitted with groups of three plastic cable ties at about three foot intervals, with the tails of the cable ties radiating out to the interior wall of the mast. This will hold the cable off the mast wall somewhat, but will not avoid abrasion from halyards or other cables. On wooden masts it is usual for the cable to be run externally.

A top quality antenna such as the Metz, combined with the correct cable and well made connections, will release the full potential of your VHF radio.